

## **MAINTENANCE, CALIBRATION, AND REPAIR OF THE TEOM**

**Purpose** This Meteorology and Air Quality Group (MAQ) procedure describes the maintenance and repair of the Tapered Element Oscillating Microbalance (TEOM).

**Scope** This procedure applies to the individuals assigned to maintain, calibrate, and repair the TEOM.

**In this procedure**

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**Hazard Control Plan** The hazard evaluation associated with this work is documented in Attachment 1: Initial risk = **low**. Residual risk = **minimal**. Work permits required: none. First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

**Signatures**

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Work authorized by:  _____ Jean Dewart, MAQ Group Leader	Date:  <u>10/20/2003</u>

10/20/03

### **CONTROLLED DOCUMENT**

This copy is uncontrolled if no signatures are present or if the copy number stamp is black. Users are responsible for ensuring they work to the latest approved revision.

## General information about this procedure

**Attachments** This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Hazard Control Plan	2

**History of revision**

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	6/2/00	New document.
1	10/21/03	Changed annual cleaning frequency, revised flow auditing chapter, rearranged chapters on leak checking and flow auditing, and added block on mass transducer calibration verification.

**Who requires training to this procedure?**

The following personnel require training before implementing this procedure:

- Anyone repairing, calibrating or maintaining TEOMs

Annual retraining is required and will be on-the-job training.

**Training method**

The training method for this procedure is **on-the-job** training by a previously-trained individual and is documented in accordance with the procedure for training (MAQ-024).

**Prerequisites**

In addition to training to this procedure, the following training is also required prior to performing this procedure:

- First Aid and Cardiopulmonary Resuscitation (CPR)
- MAQ-011, "Logbook Use and Control"
- MAQ-233, "Operation of the TEOM Air Sampling System"
- Rupprecht and Patashnick Operating Manual for TEOM

Periodically review the field safety information in the New Employee Handbook (see MAQ-032).

## General information, continued

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### Definitions specific to this procedure

TEOM: Tapered Element Oscillating Microbalance. This instrument draws ambient air through a filter that is continuously weighed, giving real-time mass concentrations.

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### References

The following documents are referenced in this procedure:

- MAQ-011, “Logbook Use and Control”
  - MAQ-024, “Personnel Training”
  - MAQ-032, “Orienting New Employees”
  - MAQ-233, “Operation of the TEOM Air Sampling System”
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### Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

## Cleaning the PM-10 inlet

**When to clean the PM-10 inlet** Clean the inlet annually or when stored mass concentration values become erratic or appear inconsistent with weather conditions or other TEOMs.

**Materials needed** Collect the materials listed below:

- General purpose cleaner
- Cotton swabs
- Small soft-bristle brush
- Paper towels
- Silicone-based stopcock grease
- Small phillips screwdriver

**Steps to clean the PM-10 inlet** To clean the inlet, perform the following steps:

Step	Action
1	Lift off the PM-10 inlet.
3	Unscrew the top acceleration assembly from the bottom collector assembly.
4	Mark the top plate deflector cone and lower plate with a pencil to facilitate proper orientation during reassembly.
5	Remove the four pan head screws from the top plate and lift off the top plate.
6	Lift the insect screen off the lower plate rain deflector and brush off. Replace.
7	Clean the top plate deflector cone and internal wall surface of the acceleration assembly with a general purpose cleaner and paper towels.
8	Clean the acceleration nozzle with a cleaner-dampened cotton swab.
9	Inspect the large diameter impactor nozzle O-ring for wear. Replace if necessary, or using a light coating of silicone grease, apply a thin film on the O-ring and a thin film on the aluminum threads of the acceleration assembly.
10	Align the top plate markings with the lower plate markings. Replace the four screws.

*Steps continued on next page.*

## Cleaning the PM-10 inlet, continued

Step	Action
11	On the lower collector assembly, use the cleaner and paper towels and/or cotton swabs to clean the collector assembly walls and three vent tubes and the bottom side of the collector assembly, and the weep hole in the collector plate.
12	Remove the rain jar and clean. Before replacing, apply a thin coat of silicone grease to the cork gasket on the cap.
13	Inspect the 2 O-rings on the lower assembly. Replace if necessary. Coat lightly with silicone grease.
14	Reassemble the top and bottom assemblies. Hand tighten.
15	Replace the PM-10 inlet.

## Replacing the large bypass in-line filter and the flow controller filter

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### Large bypass in-line filter

Replace every 6 months during heavy use or when visibly dark or discolored due to particulate buildup. Replacing these filters immediately following an exchange of a TEOM filter allows the change to be carried out during the one-half hour flow and temperature stabilization period following the instrument reset (see MAQ-233 chapter *Filter exchange*).

Remove the existing filters with the quick-disconnect fittings and replace with the new.

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### Flow controller filter

Replace annually. Replacing these filters immediately following an exchange of a TEOM filter allows the change to be carried out during the one-half hour flow and temperature stabilization period following the instrument reset (see MAQ-233 chapter *Filter exchange*).

With a small phillips screwdriver, remove the top panel of the control unit. Exchange flow controller filters.

## Cleaning the mass flow controller and orifices

**Steps to clean the mass flow controller** Perform the following steps.

Step	Action
1	Turn off the TEOM and unplug. Turn the pump off.
2	Remove the top panel from the control unit and locate the mass flow controller in the right rear corner.
3	Disconnect the 5 connectors from the mass flow controller board.
4	Remove the mass controller board from the 4 standoffs on the flow controller assembly.
5	Once the board is removed, locate the 2 orifices on the mass flow controller upper block. Carefully remove the tiny silicon tubing from each orifice.
6	Using a ¼ inch wrench, remove the orifice.
7	Install the new orifices (or, old orifices which were cleaned in the ultrasonic cleaner) and tighten the nuts until the orifices are flush with the block.
8	Remove the 6 screws that hold the upper mass flow controller block to the lower block.
9	Remove the metal plate (diaphragm) exposed when upper block is lifted off of lower block.
10	Clean holes in lower block using a cotton swab and all-purpose cleaner.
11	Remove and inspect seals for dryness, cracks, or other damage. Replace seals and apply a light coat of silicone lubricating grease.
12	Clean diaphragm with cleaner and place onto lower block when dry.
13	Install upper block onto lower block and secure.
14	Attach the tiny silicone tubes to the orifices and install the mass flow controller board.
15	Secure the cover of the control unit and return to TEOM housing.
16	Perform a system leak test and a flow audit (see next chapter).
17	If the unit has flow controller filters (older models), replace them at this time.

## System leak test and flow audit

### Purpose of leak testing

It is necessary to leak test the TEOM to ensure no air enters the system downstream from the sample, thus reducing the volume of air that goes through the filter.

### When to perform leak test

Perform the leak test at least annually, when leaks are suspected during flow rate malfunctions, or when suggested by the troubleshooting guide in the operation manual.

### Steps to leak test the TEOM

To test the TEOM for leaks, perform the following steps:

Step	Action
1	Remove the filter cartridge (see MAQ-233 chapter <i>Filter exchange</i> ). This will prevent accidental damage occurring to the sample filter cartridge when exposed to the high pressure drop that the leak test creates.
2	On Main Screen, press the up/down arrows to display both the Main Flow and the Auxiliary Flow.
3	Turn off the pump so there is no flow and record the readings for Main and Auxiliary Flows. These are the "zero flow offset" readings.
4	Turn on the pump.
5	Remove the size-selective inlet from the flow splitter and replace it with the Flow Audit Adapter. Close the valve on the Flow Audit Adapter.
6	Observe the reading for Main Flow. Subtract the "zero flow offset" number for the Main Flow from step 3. The result of this subtraction should be less than 2% of the maximum flow (0.1 L/min).
7	Similarly, observe the reading for Auxiliary Flow. Subtract the "zero flow offset" number for the Main Flow from step 3. The result of this subtraction should be less than 2% of the maximum flow (0.4 L/min).
8	If the leak test indicates a problem, check hose fittings and other critical locations in the flow system for leaks.

### Steps to flow audit

To audit the flow, perform the following steps:



## System leak test and flow audit, continued

Step	Action
1	Attach the Dry Cal calibrator to the nozzle on the flow audit adaptor.
2	Turn on the Dry Cal calibrator. Press and hold the “read” button: total flow rate should be $\pm 10\%$ of 16.7 (15.0 to 18.4) lpm. If not, see troubleshooting guide.
3	Disconnect bypass line, plug splitter with Swagelock cap, and read Dry Cal for main flow rate: should be $\pm 10\%$ of 3.0 (2.7 to 3.3) lpm. If not, see the manual Section 8.2 or 8.4.
4	Remove the flow audit adapter from the flow splitter and replace the sample inlet on the flow splitter.
5	Replace the filter cartridge (see MAQ-233 chapter <i>Filter exchange</i> ).
6	Record data in TEOM Logbook (kept at each TEOM location).

### Mass transducer calibration verification

Annually or as time allows, perform a verification of the mass transducer calibration constant that R & P provides with the unit. For the steps to do this, refer to Section 8.5 of the Operators Manual.

These steps verify that the transducer assembly is performing the proper weight analysis based on the oscillation frequency and that it is based on accurate computations from the recorded frequency of a calibration filter with a known weight.

## Records resulting from this procedure

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### Records

The following records generated as a result of this procedure are to be submitted **annually** as records to the records coordinator:

- entries in the TEOM Logbook (made according to MAQ-011)

## HAZARD CONTROL PLAN

1. The work to be performed is described in this procedure.

**“Maintenance, Calibration, and Repair of the TEOM”**

2. Describe potential hazards associated with the work (use continuation page if needed).

Abrasions/Scrapes  
Strains from carrying CPU

3. For each hazard, list the likelihood and severity, and the resulting initial risk level (before any work controls are applied, as determined according to LIR300-00-01, section 7.2)

Abrasions/Scrapes--Occasional/Negligible = Minimal  
Strains from carrying CPU—Occasional/Moderate = Low

Overall *initial* risk: ☐ Minimal ☒ Low ☐ High

4. Applicable Laboratory, facility, or activity operational requirements directly related to the work:

☐ None ☒ List: Work Permits required? ☒ No ☐ List:

### HAZARD CONTROL PLAN, continued

5. Describe how the hazards listed above will be mitigated (e.g., safety equipment, administrative controls, etc.):

Abrasions—Never, never get in a hurry.

Strains—Use a cart to push the CPU around when practical. And remember, never get in a hurry.

6. Knowledge, skills, abilities, and training necessary to safely perform this work (check one or both):



Group-level orientation (per MAQ-032) and training to this procedure.



Other → See training prerequisites on procedure page 3. Any additional describe here:

7. Any wastes and/or residual materials? (check one) ☒ None ☐ List:

8. Considering the administrative and engineering controls to be used, the *residual* risk level (as determined according to LIR300-00-01, section 7.3.3) is (check one):



Minimal

Low



Medium (requires approval by Division Director)

9. Emergency actions to take in event of control failures or abnormal operation (check one):



None



List:

For any injuries, provide first aid and see that injured person is taken to HSR-2 or the hospital.

Signature of preparer of this HCP: This HCP was prepared by a knowledgeable individual and reviewed in accordance with requirements in LIR 300-00-01 and LIR 300-00-02.

Preparer(s) signature(s)

Name(s) (print)

/Position

Date

Signature by group leader on procedure title page signifies authorization to perform work for personnel properly trained to this procedure. This authorization will be renewed annually and documented in MAQ records.

Controlled copies are considered authorized. Work will be performed to controlled copies only. This plan and procedure will be revised according to MAQ-022 and distributed according to MAQ-030.